We claim:

1. A method of correcting color of a color image obtained by an electronic camera, comprising the steps of:

determining, using a neural network, a correction to data representative of the color image based upon an estimated illuminant of the color image; and

applying the correction to the data representative of the color image, wherein the illuminant comprises multiple sources of illumination.

2. The method of claim 1, wherein the electronic camera captures at least one still image.

3. The method of claim 1, wherein the electronic camera captures a succession of moving images.

4. A method of correcting color of a color image obtained by an electronic camera, comprising the steps of:

determining, using a multilayer perceptron model, a correction to data representative of the color image based upon an estimated illuminant of the color image; and

applying the correction to the data representative of the color image, wherein the illuminant comprises multiple sources of illumination.

5. The method of claim 4, wherein the electronic camera captures at least one still image.

6. The method of claim 4, wherein the electronic camera captures a succession of moving images.

7. The method of claim 4, wherein the multilayer perceptron model is trained based upon a dogleg trust region implementation of a Levenberg-Marquardt type algorithm.

8. The method of claim 4, further comprising the step of:

outputting an output color space of the color corrected image as a space not normalized with chromaticity coordinates the sources of illumination.

9. The method of claim 4, further comprising the step of:

using training data of each neural network as a colorimetric value under a standard source of illumination.

10. A method of correcting color of a color image obtained by an electronic camera, comprising the steps of:

determining, using a coactive neuro-fuzzy inference system model, a correction to data representative of the color image based upon an estimated illuminant of the color image; and

applying the correction to the data representative of the color image, wherein the illuminant comprises multiple sources of illumination.

11. The method of claim 10, wherein the electronic camera captures at least one still image.

12. The method of claim 10, wherein the electronic camera captures a succession of moving images.

13. The method of claim 10, wherein an integrating unit comprised of fuzzy membership functions computes a weighted sum of outputs of local expert multilayer perceptrons based upon an on-camera estimation of illumination at a time of color image capture.

14. The method of claim 13, further comprising the step of:

constructing fuzzy membership functions by applying a neural network nonlinear coordinate transformation to a white balance plane in order to characterize estimated illumination for the coactive neuro-fuzzy inference system model.

15. The method of claim 10, further comprising the step of:

training the coactive neuro-fuzzy inference system model by constructing fuzzy membership functions generated by applying a neural network nonlinear coordinate transformation to a white balance plane in order to characterize estimated illumination for the coactive neuro-fuzzy inference system model.

16. The method of claim 13, further comprising the step of:

training the coactive neuro-fuzzy inference system model by constructing fuzzy membership functions generated by applying a neural network nonlinear coordinate transformation to a white balance plane in order to characterize estimated illumination for the coactive neuro-fuzzy inference system model, wherein all parameters of fuzzy membership functions and local expert multilayer perceptrons are updated simultaneously.

17. The method of claim 13, further comprising the step of:

training the coactive neuro-fuzzy inference system model by constructing fuzzy membership functions generated by applying a neural network nonlinear coordinate transformation to a white balance plane in order to characterize estimated illumination for the coactive neuro-fuzzy inference system model, wherein all parameters of fuzzy membership functions and local expert multilayer perceptrons are updated simultaneously in conjunction with a heuristic parameter updating rule.

18. The method of claim 13, 14, 15, 16 or 17, wherein at least two of the fuzzy membership functions overlap.

19. A method of correcting color of a color image obtained by an electronic camera, comprising the steps of:

determining, using a coactive neuro-fuzzy inference system with a switching unit, a correction to data representative of the color image based upon an estimated illuminant of the color image.

20. The method of claim 10, further comprising the steps of:

finding a color conversion inverse map using separate neural networks associated with respective representative sources of illumination; and

outputting an output color space of the color corrected image as a space not normalized with chromaticity coordinates the sources of illumination.

21. The method of claim 10, further comprising the steps of:

finding a color conversion inverse map using neural networks associated with respective representative sources of illumination; and

outputting an output color space of the color corrected image as a space not normalized with chromaticity coordinates the sources of illumination.

22. The method of claim 10, further comprising the steps of:

finding a color conversion inverse map using separate neural networks associated with respective representative sources of illumination; and

using training data of each neural network as a colorimetric value under a standard source of illumination.

23. The method of claim 10, further comprising the steps of:

finding a color conversion inverse map using neural networks associated with respective representative sources of illumination; and

using training data of each neural network as a colorimetric value under a standard source of illumination.

24. An apparatus for correcting color of a color image obtained by an electronic camera, comprising:

a neural network for determining a correction to data representative of the color image based upon an estimated illuminant of the color image and for applying the correction to

the data representative of the color image, wherein the illuminant comprises multiple sources of illumination.

25. The apparatus of claim 24, wherein the electronic camera captures at least one still image.

26. The apparatus of claim 24, wherein the electronic camera captures a succession of moving images.

27. An apparatus for correcting color of a color image obtained by an electronic camera, comprising:

a multilayer perceptron model for determining a correction to data representative of the color image based upon an estimated illuminant of the color image, and for applying the correction to the data representative of the color image, wherein the illuminant comprises multiple sources of illumination.

28. The apparatus of claim 27, wherein the electronic camera captures at least one still image.

29. The apparatus of claim 27, wherein the electronic camera captures a succession of moving images.

30. The apparatus of claim 27, wherein the multilayer perceptron model is trained based upon a dogleg trust region implementation of a Levenberg-Marquardt type algorithm.

31. The apparatus of claim 27, wherein the multilayer perceptron model outputs an output color space of the color corrected image as a space not normalized with chromaticity coordinates the sources of illumination.

32. The apparatus of claim 27, wherein the multilayer perceptron model uses training data of each neural network as a colorimetric value under a standard source of illumination.

33. An apparatus for correcting color of a color image obtained by an electronic camera, comprising:

a coactive neuro-fuzzy inference system model for determining a correction to data representative of the color image based upon an estimated illuminant of the color image, and for applying the correction to the data representative of the color image, wherein the illuminant comprises multiple sources of illumination.

34. The apparatus of claim 33, wherein the electronic camera captures at least one still image.

35. The apparatus of claim 33, wherein the electronic camera captures a succession of moving images.

36. The apparatus of claim 33, wherein an integrating unit comprised of fuzzy membership functions computes a weighted sum of outputs of local expert multilayer perceptrons based upon an on-camera estimation of illumination at a time of color image capture.

37. The apparatus of claim 36, wherein fuzzy membership functions are constructed by applying a neural network nonlinear coordinate transformation to a white balance plane in order to characterize estimated illumination for the coactive neuro-fuzzy inference system model.

38. The apparatus of claim 33, wherein the coactive neuro-fuzzy inference system model is trained by constructing fuzzy membership functions generated by applying a neural network nonlinear coordinate transformation to a white balance plane in order to characterize estimated illumination for the coactive neuro-fuzzy inference system model.

39. The apparatus of claim 36, wherein the coactive neuro-fuzzy inference system model is trained by constructing fuzzy membership functions generated by applying a neural network nonlinear coordinate transformation to a white balance plane in order to characterize estimated illumination for the coactive neuro-fuzzy inference system model, wherein all parameters of fuzzy membership functions and local expert multilayer perceptrons are updated simultaneously.

40. The apparatus of claim 36, wherein the coactive neuro-fuzzy inference system model is trained by constructing fuzzy membership functions generated by applying a neural network nonlinear coordinate transformation to a white balance plane in order to characterize estimated illumination for the coactive neuro-fuzzy inference system model, wherein all parameters of fuzzy membership functions and local expert multilayer perceptrons are updated simultaneously in conjunction with a heuristic parameter updating rule.

41. The apparatus of claim 36, 37, 38, 39 or 40, wherein at least two of the fuzzy membership functions overlap.

42. An apparatus for correcting color of a color image obtained by an electronic camera, comprising:

a coactive neuro-fuzzy inference system with a switching unit for determining a correction to data representative of the color image based upon an estimated illuminant of the color image.

43. The apparatus of claim 33, wherein coactive neuro-fuzzy inference system model finds a color conversion inverse map using separate neural networks associated with respective representative sources of illumination, and outputs an output color space of the color corrected image as a space not normalized with chromaticity coordinates the sources of illumination.

44. The apparatus of claim 33, wherein coactive neuro-fuzzy inference system model finds a color conversion inverse map using neural networks associated with respective representative sources of illumination, and outputs an output color space of the color corrected image as a space not normalized with chromaticity coordinates the sources of illumination.

45. The apparatus of claim 33, wherein coactive neuro-fuzzy inference system model finds a color conversion inverse map using separate neural networks associated with respective representative sources of illumination, and uses training data of each neural network as a colorimetric value under a standard source of illumination.

46. The apparatus of claim 33, wherein coactive neuro-fuzzy inference system model finds a color conversion inverse map using neural networks associated with respective representative sources of illumination, and uses training data of each neural network as a colorimetric value under a standard source of illumination.

47. A recording medium having recorded thereon color corrected data of a color image obtained by an electronic camera, the recording medium being prepared by the steps of:

determining, using a neural network, a correction to data representative of the color image based upon an estimated illuminant of the color image;

applying the correction to the data representative of the color image, wherein the illuminant comprises multiple sources of illumination; and

recording on the recording medium data representative of the corrected data.

48. The recording medium 47, wherein the electronic camera captures at least one still image.

49. The recording medium of claim 47, wherein the electronic camera captures a succession of moving images.

50. A recording medium having recorded thereon color corrected data of a color image obtained by an electronic camera, the recording medium being prepared by the steps of:

determining, using a multilayer perceptron model, a correction to data representative of the color image based upon an estimated illuminant of the color image;

applying the correction to the data representative of the color image, wherein the illuminant comprises multiple sources of illumination; and

recording on the recording medium data representative of the corrected data.

51. The recording medium of claim 50, wherein the electronic camera captures at least one still image.

52. The recording medium of claim 50, wherein the electronic camera captures a succession of moving images.

53. The recording medium of claim 50, wherein the multilayer perceptron model is trained based upon a dogleg trust region implementation of a Levenberg-Marquardt type algorithm.

54. The recording medium of claim 54, further comprising the step of:

outputting an output color space of the color corrected image as a space not normalized with chromaticity coordinates the sources of illumination.

55. The recording medium of claim 50, further comprising the step of:

using training data of each neural network as a colorimetric value under a standard source of illumination.

56. A recording medium having recorded thereon color corrected data of a color image obtained by an electronic camera, the recording medium being prepared by the steps of:

determining, using a coactive neuro-fuzzy inference system model, a correction to data representative of the color image based upon an estimated illuminant of the color image;

applying the correction to the data representative of the color image, wherein the illuminant comprises multiple sources of illumination; and

recording on the recording medium data representative of the corrected data.

57. The recording medium of claim 56, wherein the electronic camera captures at least one still image.

58. The recording medium of claim 56, wherein the electronic camera captures a succession of moving images.

59. The recording medium of claim 56, wherein an integrating unit comprised of fuzzy membership functions computes a weighted sum of outputs of local expert multilayer perceptrons based upon an on-camera estimation of illumination at a time of color image capture.

60. The recording medium of claim 59, further comprising the step of:

constructing fuzzy membership functions by applying a neural network nonlinear coordinate transformation to a white balance plane in order to characterize estimated illumination for the coactive neuro-fuzzy inference system model.

61. The recording medium of claim 56, further comprising the step of:

training the coactive neuro-fuzzy inference system model by constructing fuzzy membership functions generated by applying a neural network nonlinear coordinate transformation to a white balance plane in order to characterize estimated illumination for the coactive neuro-fuzzy inference system model.

62. The recording medium of claim 59, further comprising the step of:

training the coactive neuro-fuzzy inference system model by constructing fuzzy membership functions generated by applying a neural network nonlinear coordinate transformation to a white balance plane in order to characterize estimated illumination for the coactive neuro-fuzzy inference system model, wherein all parameters of fuzzy membership functions and local expert multilayer perceptrons are updated simultaneously.

63. The recording medium of claim 59, further comprising the step of:

training the coactive neuro-fuzzy inference system model by constructing fuzzy membership functions generated by applying a neural network nonlinear coordinate transformation to a white balance plane in order to characterize estimated illumination for the coactive neuro-fuzzy inference system model, wherein all parameters of fuzzy membership functions and local expert multilayer perceptrons are updated simultaneously in conjunction with a heuristic parameter updating rule.

64. The recording medium of claim 59, 60, 61, 62 or 63, wherein at least two of the fuzzy membership functions overlap.

65. A recording medium having recorded thereon color corrected data of a color image obtained by an electronic camera, the recording medium being prepared by the steps of:

determining, using a coactive neuro-fuzzy inference system with a switching unit, a correction to data representative of the color image based upon an estimated illuminant of the color image; and

recording on the recording medium data representative of the corrected data.

66. The recording medium of claim 56, further comprising the steps of:

finding a color conversion inverse map using separate neural networks associated with respective representative sources of illumination; and

outputting an output color space of the color corrected image as a space not normalized with chromaticity coordinates the sources of illumination.

67. The recording medium of claim 56, further comprising the steps of:

finding a color conversion inverse map using neural networks associated with respective representative sources of illumination; and

outputting an output color space of the color corrected image as a space not normalized with chromaticity coordinates the sources of illumination.

68. The recording medium of claim 56, further comprising the steps of:

finding a color conversion inverse map using separate neural networks associated with respective representative sources of illumination; and

using training data of each neural network as a colorimetric value under a standard source of illumination.

69. The recording medium of claim 56, further comprising the steps of:

finding a color conversion inverse map using neural networks associated with respective representative sources of illumination; and

using training data of each neural network as a colorimetric value under a standard source of illumination.

70. A method of transmitting color corrected data of a color image obtained by an electronic camera, comprising the steps of:

determining, using a neural network, a correction to data representative of the color image based upon an estimated illuminant of the color image;

applying the correction to the data representative of the color image, wherein the illuminant comprises multiple sources of illumination; and

transmitting data representative of the corrected data.

71. The method of claim 70, wherein the electronic camera captures at least one still image.

72. The method of claim 70, wherein the electronic camera captures a succession of moving images.

73. A method of transmitting color corrected data of a color image obtained by an electronic camera, comprising the steps of:

determining, using a multilayer perceptron model, a correction to data representative of the color image based upon an estimated illuminant of the color image;

applying the correction to the data representative of the color image, wherein the illuminant comprises multiple sources of illumination; and

transmitting data representative of the corrected data.

74. The method of claim 73, wherein the electronic camera captures at least one still image.

75. The method of claim 73, wherein the electronic camera captures a succession of moving images.

76. The method of claim 73, wherein the multilayer perceptron model is trained based upon a dogleg trust region implementation of a Levenberg-Marquardt type algorithm.

77. The method of claim 73, further comprising the step of:

outputting an output color space of the color corrected image as a space not normalized with chromaticity coordinates the sources of illumination.

78. The method of claim 79, further comprising the step of:

using training data of each neural network as a colorimetric value under a standard source of illumination.

79. A method of transmitting color corrected data of a color image obtained by an electronic camera, comprising the steps of:

determining, using a coactive neuro-fuzzy inference system model, a correction to data representative of the color image based upon an estimated illuminant of the color image;

applying the correction to the data representative of the color image, wherein the illuminant comprises multiple sources of illumination; and

transmitting data representative of the corrected data.

80. The method of claim 79, wherein the electronic camera captures at least one still image.

81. The method of claim 79, wherein the electronic camera captures a succession of moving images.

82. The method of claim 79, wherein an integrating unit comprised of fuzzy membership functions computes a weighted sum of outputs of local expert multilayer perceptrons based upon an on-camera estimation of illumination at a time of color image capture.

83. The method of claim 82, further comprising the step of:

constructing fuzzy membership functions by applying a neural network nonlinear coordinate transformation to a white balance plane in order to characterize estimated illumination for the coactive neuro-fuzzy inference system model.

84. The method of claim 79, further comprising the step of:

training the coactive neuro-fuzzy inference system model by constructing fuzzy membership functions generated by applying a neural network nonlinear coordinate

transformation to a white balance plane in order to characterize estimated illumination for the coactive neuro-fuzzy inference system model.

85. The method of claim 82, further comprising the step of:

training the coactive neuro-fuzzy inference system model by constructing fuzzy membership functions generated by applying a neural network nonlinear coordinate transformation to a white balance plane in order to characterize estimated illumination for the coactive neuro-fuzzy inference system model, wherein all parameters of fuzzy membership functions and local expert multilayer perceptrons are updated simultaneously.

86. The method of claim 82, further comprising the step of:

training the coactive neuro-fuzzy inference system model by constructing fuzzy membership functions generated by applying a neural network nonlinear coordinate transformation to a white balance plane in order to characterize estimated illumination for the coactive neuro-fuzzy inference system model, wherein all parameters of fuzzy membership functions and local expert multilayer perceptrons are updated simultaneously in conjunction with a heuristic parameter updating rule.

87. The method of claim 82, 83, 84, 85 or 86 wherein at least two of the fuzzy membership functions overlap.

88. A method of transmitting color corrected data of a color image obtained by an electronic camera, comprising the steps of:

determining, using a coactive neuro-fuzzy inference system with a switching unit, a correction to data representative of the color image based upon an estimated illuminant of the color image; and

transmitting data representative of the corrected data.

89. The method of claim 79, further comprising the steps of:

finding a color conversion inverse map using separate neural networks associated with respective representative sources of illumination; and

outputting an output color space of the color corrected image as a space not normalized with chromaticity coordinates the sources of illumination.

90. The method of claim 79, further comprising the steps of:

finding a color conversion inverse map using neural networks associated with respective representative sources of illumination; and

outputting an output color space of the color corrected image as a space not normalized with chromaticity coordinates the sources of illumination.

91. The method of claim 79, further comprising the steps of:

finding a color conversion inverse map using separate neural networks associated with respective representative sources of illumination; and

using training data of each neural network as a colorimetric value under a standard source of illumination.

92. The method of claim 79, further comprising the steps of:

finding a color conversion inverse map using neural networks associated with respective representative sources of illumination; and

using training data of each neural network as a colorimetric value under a standard source of illumination.

93. The method of claim 1, 4 or 10, wherein the data representative of the color image includes information regarding the illuminant.

94. The apparatus of claim 24, 27 or 33, wherein the data representative of the color image includes information regarding the illuminant.

95. A method of recording image data obtained by an electronic camera, comprising the steps of:

capturing a color image and generating data representative of the image;

estimating an illuminant for the captured color image and generating data representative of the estimated illuminant; and

recording the data representative of the image with the data representative of the estimated illuminant.

96. A method of transmitting image data obtained by an electronic camera, comprising the steps of:

capturing a color image and generating data representative of the image;

estimating an illuminant for the captured color image and generating data representative of the estimated illuminant; and

transmitting the data representative of the image with the data representative of the estimated illuminant.